Investigations of Rhinoceros Beetles in West Africa[1]

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IN APRIL, 1959, the author was sent by the South Pacific Commission to the countries of Sierra Leone and Nigeria, West Africa, to conduct an investigation of the natural enemies of the various species of *Oryctes* (Coleoptera, Scarabaeidae, Dynastinae) occurring there. The object of this study was to find and introduce to the islands of the South Pacific suitable parasites and predators of these beetles in order to establish a biological control over the introduced *Oryctes rhinoceros* Linn. which has become a serious pest of coconut palms in the area.

In Sierra Leone and Nigeria, coconut palms are confined mostly to village sites; the groves are from 15 to 50 palms, depending on the size of the village. Because of this, nearly all the work was carried out on oil palms (*Elaeis guineensis* Jacq.) which, together with the *Raphia* palms of the swamps, are the most important hosts of the species of *Oryctes* found. The oil palms occur in an extensive belt that follows the coast of West Africa and extends inland nearly 100 miles in some places.

There are two distinct climatic seasons in West Africa, and these greatly affect the insect populations. The wet season begins generally at the end of April and lasts until sometime in September. By the end of November the dry season has set in, and from then until April little or no rain falls. At times the rains will cease in August and commence again in September, but during 1960 this type of rainfall did not occur in Nigeria.

Insect activity begins with the coming of the rains in April or May and gradually ends in November or December. There are, of course, many exceptions to this; some species seem to be found only during the dry season and others congregate along streams and in swamps, giving a false impression of their absence.

During the dry season in Sierra Leone and in parts of Nigeria, it is the practice to burn off the bush to clear the land for planting. The oil palms in these areas are usually not affected by the fires, and the larvae of *Oryctes* and other beetles within the standing rotten trunks are not harmed.

The low-lying land of the southern part of eastern Nigeria is divided by numerous slow-moving streams which give rise to large swampy areas as they wind their way towards the sea. Because of this and the heavy rainfall, extensive burning is not possible. In the swamps are dense stands of *Raphia* palms which flower and die, providing a continuous supply of breeding sites for *Oryctes*. The higher ground between the streams and swamps supports large stands of oil palms, both cultivated and wild, from which come the main export of the area in the form of palm oil and kernels.

PREDATORS AND PARASITES ENCOUNTERED

Neochryopus savagei Hope (Coleoptera, Caraboidea, Scaritidae)

The large scaritid beetle *Neochryopus savagei* was first found in *Raphia* palms growing in the swamps at Umudike, near Umuahia, eastern Nigeria. In April, 1960, an adult beetle of this species was found inside a standing rotten *Raphia* palm trunk where it was actually engaged in feeding on a larva of *Oryctes ohausi* Minck. A search of other rotten palm trunks in this area turned up two large larvae of *Neochryopus*. Afterwards, additional adult specimens were recovered from the debris which normally collects in the old dead leaf bases just below the crowns of oil palms left by workers engaged in cutting the bunches of fruit in a grove of palms on the Agricultural Station. This accumulation of rotten organic matter provides a breeding site for *Oryctes sjöstedti* Koble, and *Neochryopus* breeds here and preys on these dynastid grubs.

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Data obtained from the examination of field-collected larvae of *N. savagei* indicated that there were five instars. The length of the fourth instar period of a single larva provided with a constant supply of small cetonid and *Oryctes* grubs was slightly over 2 weeks. The pupal period was 10 days. Several of these scaritid larvae lived 3 weeks without food. Considerable difficulty was experienced in hatching the eggs laid by captive adult beetles and rearing their larvae in the laboratory because both stages were frequently attacked by fungus. In the case of the larvae this fungus appeared to be a *Metarrhizium.*

The adult beetles mated readily in small cigarette tins (14 cubic inches in capacity), which were partly filled with moist rotten palm fiber. The eggs of these scaritids were found in the medium, there being one egg per beetle. In a single instance a second egg was laid 3 days after the first had been discovered. The eggs were oval in shape, about 2 mm long and ½ mm wide. When laid they were sticky, and quickly became covered with bits of frass. This made them hard to find and, as no special attempts were made to discover them, no doubt many were missed. Adult female beetles which were dissected contained a maximum of four large eggs.

Both the adults and larvae of *N. savagei* readily attacked, killed, and consumed cetonid, *Oryctes,* and other dynastid grubs of a size up to 10 g in weight (the size of an early third instar *Oryctes* larva). The larvae of the palm weevil, *Rhynchophorus phoenicis* F., were offered to the adult beetles and while these were usually killed, the beetles did not seem to feed on them to any extent.

The adult scaritids survived for long periods without food, the maximum period noted being about 4 weeks.

The adult beetles are winged and are strong fliers. Occasionally they are attracted to lights at night.

The sexes are readily distinguishable. The mandibles of the male are elongated, and the distal portion is without well-developed horizontal teeth. Those of the female are slightly broader and shorter, and the left mandible has a broad, flattish, horizontal inner tooth which forms a subapical notch. The mandibles of the males are apparently adapted for grasping the female around the back of the head during copulation. However, both sexes feed readily on scarabaeid grubs.

The sex ratio was found to be 1 to 1. Usually one or two adult beetles were found in the debris of an oil palm, but on one occasion four were taken in a single site. No figures were obtained on the sexes collected from individual palms; the ratios were calculated from total field collections.

The majority of the beetles were collected from the oil palm debris; however, a fairly large number of both adults and larvae were also found in the rotten *Raphia* trunks. The fauna of the oil palm trash and of the standing rotten trunks was, with one exception, identical. The exception was *Oryctes sjöstedti,* which was only found breeding in the oil palms. However, it seems safe to regard this site as a sort of elevated trash heap rather than an unique environment.

At Umudike the beetles were kept in round, 50-cigarette-size tins. At first only one adult was put in each tin, but later, to conserve space, two were placed in each container. Rotten palm fibre was added to each tin to give the beetles something in which to dig. After about 1,400 specimens had been collected at Umudike, they were taken to Ibadan and there packed for shipment. Plywood trays divided by partitions into 2-inch cubes were used to hold the beetles in transit. Each cube was partly filled with moist wood wool. A single scaritid was placed in each compartment, and the tray was covered with ⅛-inch-mesh wire screen held down with staples. Three or more trays were then packed into a heavy polythene bag to prevent loss of moisture. The trays in their bags were packed into heavy cardboard boxes which were wrapped with paper. From 4 to 6 boxes made up a shipment. The insects were sent from the Ikeja airport via Paris to Fiji by air freight. Cigarette tins were used as containers for the first two or three shipments, but these were heavier than the plywood trays.

During the shipments, there were always more beetles than containers. Usually, enough males were discarded to bring the sex ratio to 1 male to 3 females instead of the normal 1 to 1. An ideal container would have been an alumi-

num box of about 8 cubic inches capacity, and had these been available in quantity many more insects could have been sent.

An attempt was made to keep *N. savagei* adults together in a large tin, but this was unsuccessful due to cannibalism even when 8 cubic inches were allowed per beetle.

At first it was thought desirable to provide food for the insects during the time they were held in Nigeria. Later it was found that they fared much better if they were not fed. The grubs put into the tins were only partly consumed, and the rotting remains in the small containers evidently created a most unfavorable environment.

Dorylus (Anomma) nigricans Ill. (Hymenoptera, Formicidae, Dorylinae)

Throughout the search for parasites and predators of *Oryctes* in West Africa it was noted that the larvae of the rhinoceros beetles occurred in large numbers in standing rotten palm trunks but not in fallen logs. In Sierra Leone this situation was often observed, but no experiments were made to determine why the fallen logs were not used by the beetles. It was thought that possibly the principal species encountered, *Oryctes owariensis* Beauv., unlike other members of the genus, did not favour such sites.

On Moor Plantation, Ibadan, Nigeria, an experimental grove of coconut palms was found to be infested by a fair number of *Oryctes monoceros* Ol. This species was found breeding inside the bases of old coconut palm stumps and in standing rotten coconut trunks, the products of several severe lightning strikes in the grove. However, in the numerous rotten trunks which had been felled, there were no *Oryctes* larvae nor, for that matter, any larvae of any of the numerous species of cetonids and small dynastids which usually occur with *Oryctes* in West Africa. There were clear signs that, before the trunks had been felled, a considerable amount of breeding by *Oryctes* had taken place within them. It was also noted that the hollowed interiors of these fallen trunks contained much less frass than would have been expected.

Specimens of adult rhinoceros beetles from this grove were sent to the British Museum (Natural History) with a request that they be compared with specimens of *Oryctes monoceros* from East Africa. This was done, and the Ibadan species was found to be identical with the East African *O. monoceros.*

To determine whether the fallen trunks were suitable as breeding sites, four sections were selected and set upright. After these had been in position for about 3 weeks, they were split open. Seven adult beetles of *O. monoceros* and 14 eggs were collected from them.

Five sections of the fallen trunks were carefully split lengthwise, and new hollows were either carved out by hand or the existing hollows were utilized. These prepared sections were stocked with *Oryctes* larvae, and frass was packed into the hollows around them. The two halves were then brought together and fastened in place with bands of wire. Some sections were left lying on the ground, others were raised slightly at one end. In addition to the logs, a sawdust pile was established and stocked with larvae of *O. boas* F. and a few *O. owariensis.* For all of these trials only third-instar larvae were available.

The following events took place:

1. *15 November 1959.* One log was entered, and the larvae were eaten by a small greyish rat.

2. *30 November 1959.* All the logs were entered, the frass was removed, and the larvae were eaten by a swarm of "driver" ants, *Dorylus (Anomma) nigricans.*

3. *14 December 1959.* The logs, having been restocked with *Oryctes* larvae, were again entered, the frass was removed, and the larvae were eaten by a very large swarm of "driver" ants, *Dorylus (Anomma) nigricans.* The sawdust pile was also entered by the ants and about one-third of the grubs was eaten.

4. *10 January 1960.* Additional logs were added on 3, 4 January and a small section of log which could be moved about with ease was prepared. This was placed in the dry bed of a stream, about 50 m distant, where "driver" ants had been observed. On the evening of 10 January the ants invaded this log and also entered all the other logs in the experimental area. One of these logs was constructed so that the larvae were in a central frass-packed hollow which had no openings at either end. The only means of access to this hollow were the holes left in the

trunk by the workings of xylocopid bees, a natural feature of all of the rotten logs in the grove. The ants entered through these holes, removed the frass, and ate the *Oryctes* larvae, leaving only the head capsules.

5. *11 January 1960.* The logs which had been invaded by the "driver" ants on the night of the 10th were broken up to determine if any of the *Oryctes* larvae had escaped. In three of the logs in the upper breeding site experimental area a few intact larvae and pupae were found, but in the log located in the stream bed nothing remained. The following results were obtained from the logs in the upper area: One log which had been stocked with 7 larvae contained 1 living larva and 1 pupa; one log which had been stocked with 10 larvae contained 2 living larvae and 1 pupa; one log with no access from either end which had been stocked with 6 larvae contained 1 living larva and 1 pupa.

The area was visited daily and the logs were inspected at intervals of 4 to 5 days to determine if the larvae were alive. The last stocking of the logs with larvae was on 16 December 1959.

In November, the end of the wet season in Nigeria, the ants were active throughout the area. However, after the end of the rains the ants moved into stream beds; by January, only invasions of short duration were made into nearby areas.

The invasion of the experimental site on 30 November lasted about 14 hr. The last sortie on 10 January was only about 7 hr long.

Another species of *Dorylus* (*Anomma*) was found in the coconut grove; this ant was never observed to enter the logs. No attempts were made by either species of *Dorylus* (*Anomma*) to enter the tops of the stumps or to climb up the standing trunks. The ants were able to climb vertical surfaces but did not seem to do any work, such as removing frass, while on them. When *D. nigricans* entered the rotten logs, they did so by choosing holes which were more or less horizontal. They always used these holes to bring out the frass from the interior.

Ochryopus gigas Schio. (Coleoptera, Caraboidea, Scaritidae)

Occasionally the very large scaritid *Ochryopus gigas* was found both in the debris accumulated below the crowns of oil palms and in standing rotten palm trunks. During April and May, 1960, adults of this species were taken around lights at night. However, this species was never found to be common and its larva was not discovered. In the laboratory *O. gigas* attacked, killed, and consumed both larvae and adults of *Oryctes.*

Scolia sp. (Hymenoptera, Scoliidae)

In the oil palm debris and in rotten *Raphia* trunks large *Scolia* cocoons were frequently found. Many of those taken from these sites had already hatched. Sometimes the head capsule of the host grub would be found entangled in the silk of the cocoon, and from this it was determined to be parasitic on *Oryctes ohausi* and *O. sjöstedti.*

The adult wasps were never observed in the field, but two males and two females were bred out in the laboratory. The female specimens were sent to the British Museum (Natural History), where they were identified only as *Scolia* sp., "not in British Museum collection."

Judging from the number of empty cocoons, this parasite was thought to be rather common, but large-scale collecting efforts resulted in only about 65, nearly half of which contained dead pupae. Nevertheless, the cocoons were sent to Fiji where an attempt was made to rear the wasps. Unfortunately, this has proved unsuccessful, and the wasps which did hatch died in the laboratory.

OTHER PREDATORS AND PARASITES

1. *Alaus* ? sp., *Calais* sp. (Coleoptera, Elateridae)
2. *Morio guineensis* Imh. (Coleoptera, Caraboidea, Carabidae)
3. Genus ?, species ? (Diptera, Tachinidae)
4. *Platymerus biguttata* Stäl (Hemiptera, Reduviidae)
5. Genus? species? (Diptera, Tabanidae)
6. Genus? species? (Araneida, Aviculariidae)

1. Large elaterid larvae were found inside the standing rotten oil palm trunks in close proximity to *Oryctes* larvae in both Sierra Leone and

Nigeria. They were never common, and in Sierra Leone only 24 were collected from over 500 rotten oil palm trunks. Specimens were determined at the British Museum to be perhaps a species of *Alaus*.

A smaller elaterid larva found in a rotten oil palm was reared on *Oryctes* and cetonid larvae, the adult beetle being identified as *Calais* sp.

2. Occasionally larvae and adults of a small carabid beetle, *Morio guineensis,* were found in the frass in the rotten palm trunks. In the laboratory these readily consumed first instar *Oryctes* larvae.

3. Large numbers of the larvae of *Oryctes boas* F., collected from a manure heap on the farm of the University College, Ibadan, were reared in captivity. These were dissected whenever they showed signs that something was wrong with them. One, a prepupal stage larva, died suddenly and was cut open. In the abdomen was a very large larva of a tachinid fly which had also perished. Following this discovery, some 1,000 *Oryctes boas* grubs were collected from this manure heap, but no other parasites were recovered.

4. Neanides and adults of the large reduviid, *Platymerus biguttata,* were found fairly frequently in the open hollow tops of the standing rotten oil palm trunks in Sierra Leone during April, May, and June. Laboratory trials were conducted to see if this bug would prey on adult *Oryctes owariensis,* but without result. Even adults which had been held without food for nearly 2 weeks showed no interest in this large rhinoceros beetle. During May and June, 1959, *Platymerus biguttata* came to lights at night on several occasions. No other Coleoptera than *Oryctes owariensis* were tried as prey for this reduviid.[2]

5. In a standing rotten coconut palm trunk on Moor Plantation, Ibadan, three tabanid larvae were found in the frass along with the grubs of *Oryctes monoceros.* These readily attacked and killed young scarabaeid larvae in captivity. A week or so later all three pupated and after 2 weeks the adult flies emerged. Unfortunately, the specimens sent to the British Museum were badly broken in transit and were not able to be identified. The tabanids were bright orange with a large purple band across each wing.

6. In Sierra Leone, both inside the hollow tops of standing rotten oil palm trunks and in the crowns of living oil palms, a large avicularid spider was frequently encountered. This fearsome-looking arachnid evidently attacked the oil palm climbers, who had their own remedy for the effects of its bite. Experiments were made to see if this spider would kill adult *Oryctes owariensis,* but the results were negative.

In Nigeria this palm tarantula seemed to be unknown to the people and no specimens were found.

Coleolaelaps sp. (Acarina, Laelaptidae)

Several investigators have reported that mites feed on the eggs of *Oryctes.* Venkatraman reported a *Coleolaelaps* sp. which "apparently fed on *Oryctes* eggs" in Ceylon. Surany reported several instances of mites feeding on *Oryctes* eggs and stated that they were important under certain circumstances in its control. Unfortunately, Surany did not identify the mite in question in his report.[3]

Clusters of mites around eggs of *Oryctes owariensis* were frequently observed in Sierra Leone from June onward throughout the rainy season in 1959. These mites were found on eggs enclosed in balls of frass formed by the adult beetles as they oviposited in the rotten wood inside the standing rotten oil palm trunks. It was noted at the time that eggs which had mites on them never hatched, while eggs in the vicinity without mites hatched readily. These mites were collected and sent to the British Museum where they were identified as *Coleolaelaps* sp.

Adult mites of this species were common on the larvae of *Oryctes owariensis, O. boas,* and *O. monoceros,* but were encountered only rarely on the adult beetles.

[2] The author is at present engaged in a study of the allied species, *Platymerus rhadamanthus* Gerst., which does attack the adults of *Oryctes monoceros* Ol. However, old adults which have accumulated large fat deposits usually refuse to attack anything. At the time *Platymerus biguttata* was investigated it was not known that the fifth-instar neanides would also attack adult rhinoceros beetles and, perhaps because of their more rapid metabolism, are generally easier subjects with which to work.

[3] *Diseases and Biological Control in Rhinoceros Beetles.* South Pacif. Com. Tech. Pap. 128. 1960.

In Nigeria, *Coleolaelaps* was again found on the eggs of *Oryctes boas* in March, 1960, following a few early rains. The *Oryctes* eggs were taken in a large manure heap on the farm of the University College, Ibadan. Mite-infested eggs were collected and placed for observation in covered shallow glass dishes filled with a manure and frass mixture. At the same time newly laid eggs were obtained from captive specimens of *Oryctes boas*. Mite eggs and immature and adult mites were transferred from the originally infested, field-collected eggs to the newly laid eggs and to uninfested, field-collected eggs.

It was noted that *Oryctes* eggs which had mites or mite eggs on them were all slightly discoloured and at times showed brownish spots.

When mite eggs were transferred to nondiscoloured, field-collected eggs, or to newly laid eggs, the mites hatched and in a short time made their way throughout the medium to the original egg from which they had been transferred. Here they gathered and fed on the yolk of the now partly collapsed egg.

The adult *Coleolaelaps* were never observed to feed on either nondiscoloured, field-collected eggs or on the newly laid eggs, but they fed readily on the discoloured ones and on a nondiscoloured egg which was punctured with a needle.

None of the discoloured eggs hatched and, with the exception of the punctured, nondiscoloured egg, both newly laid and field-collected ones produced normal larvae.

No further tests were carried out with *Coleolaelaps* due to the discovery of other predators which appeared to be more promising.

OTHER MITES ASSOCIATED WITH *Oryctes*

In all, some 14 species of mites (Acarina, Uropodina, and Canestrinidae) were found associated with the larvae and adults of *Oryctes* in Nigeria. Two of these, a canestriniid and a species of the Uropodina, were found commonly on the adults of *Oryctes monoceros* and *O. owariensis*. The canestriniid was found in large numbers on the first three abdominal tergites beneath the elytra. The uropodinid was taken wandering about both on the venter of the beetle and under the wing cases. At times both species of mites were found heavily infested with a fungus resembling closely some of the Laboulbeniales. The fungus did not appear to harm them, and gravid females were frequently observed to produce normal eggs in spite of heavy infestations.

The species of Uropodina found on *Oryctes* was also collected in numbers from the adults of *Neochryopus savagei*.

SPECIES OF *Oryctes* ENCOUNTERED (Coleoptera, Scarabaeidae, Dynastinae)

1. *Oryctes monoceros* Olivier

Both in Sierra Leone and in Nigeria *Oryctes monoceros* was always found in places where there were coconut palms in the immediate vicinity. On Moor Plantation, Ibadan, this species was taken breeding in standing rotten coconut trunks and in the bases of coconut stumps. With the exception of Moor Plantation, however, *O. monoceros* was rare in all of the places visited.

2. *Oryctes boas* Fabricius

In Sierra Leone *Oryctes boas* was commonly encountered breeding in village compost heaps, but in similar sites in Nigeria it was rare. However, in Nigeria a large manure pile was found at the farm of the University College, Ibadan, in which there were thousands of larvae, pupae, and adults of this species. In March and early April numerous adults and eggs were found in this site, but at other times mainly larvae of various instars were present. These findings seemed to indicate that, while there was some overlap of generations, nevertheless there was a definite yearly cycle.

Recently an experimental planting of oil palms in Northern Nigeria was reported to be rather severely attacked by an *Oryctes*, and specimens extracted from the crowns of these palms proved to be *O. boas*.

3. *Oryctes owariensis* Palisot de Beauvois

Oryctes owariensis is a large species, the well-developed adults being larger than the other *Oryctes* species in West Africa and larger than *O. rhinoceros* of Southeast Asia and the Pacific

region. Probably because of its size, the species has been confused with *O. gigas* of Madagascar.

Oryctes owariensis breeds, as far as is known, only in rotten wood and prefers rotten palm logs. It was found commonly in Sierra Leone and Nigeria in standing rotten oil palm trunks, standing rotten coconut trunks, and in rotten *Raphia* palm trunks. Usually this was the only species of *Oryctes* present in these sites, but sometimes the larvae of *O. monoceros* or *O. ohausi* occurred with it. In Sierra Leone an adult specimen was extracted from the crown of an oil palm. Observations in both Sierra Leone and Nigeria seemed to indicate that this beetle did not prefer coconut palms as a host plant.

4. *Oryctes sjöstedti* Kolbe

As has been stated previously, this species was only taken breeding in the debris accumulated in the dead leaf bases just below the crowns of oil palms. In this site the maximum number of larvae found was six, all third instars. Pupae were not infrequently encountered, usually in a cavity within one of the old leaf bases; the adult beetles were also found both within these and in the debris enclosed by them. Adults were taken at mercury vapour lights fairly frequently, but never in numbers; one or two per night was the largest catch. This species was most common at Benin, Nigeria, on the West African Institute for Oil Palm Research station and at Umudike in eastern Nigeria.

5. *Oryctes ohausi* Minck

Perhaps this species has been confused with *O. monoceros* in the past; anyway when specimens were sent to the British Museum for determination, it was surprising to learn that no examples of this species were in the collection. *O. ohausi* was commonly found breeding in the standing rotten trunks of *Raphia* palms. Adults, larvae, and pupae were found in fair numbers in these sites, and not infrequently in company with *O. owariensis*. There was an average of eight larvae per trunk during April, 1960, at Umudike in eastern Nigeria. A single adult male was taken in a rotten oil palm stump on Moor Plantation at Ibadan.

6. *Oryctes erebus* Burmeister

This species has been recorded a number of times from West Africa but was not found during this investigation.

NOTES CONCERNING ADULTS OF *Oryctes*

All of the investigations conducted in West Africa on the adults of the various species of *Oryctes* were carried out with the objective of finding parasites of the mature beetles.

The main difficulty in searching for parasites of the adults is to get large numbers of beetles which have been exposed in nature. When mature beetles are taken from rotten logs, a fairly high proportion of them are recently emerged and have never been outside the breeding site. If *Oryctes* flew readily to lights, the problem would be simple. However, it is not particularly attracted by light, although recently some success has been reported with a special ultra-violet lamp used in the Pacific.

In Western Samoa split logs laid flat on the ground are used to trap adult rhinoceros beetles. Each trap consists of four to eight logs each about 4 ft long. A similar type of trap was tried in Nigeria without success.

Another type of rotten log trap was devised which gave fairly good results in Nigeria. This was made of a foot-long section of coconut trunk through which a hole was bored from end to end. This section was placed on top of a No. 10 can which was either sunk into or rested on a coconut stump. The beetles landed on the top of the log, crawled down the hole and fell into the can underneath. The trap caught quite a few *Oryctes monoceros,* the largest single catch being three.

Efforts were made to use captive beetles to attract others. No positive results were obtained along this line, but it was found that *O. owariensis* had two distinct flight times, one in the evening and the other in the early morning. Furthermore, beetles which did not fly in the evening flew in the morning, and beetles which did fly after sundown did not fly later on.

No parasites were found in the adults of *Oryctes,* but the numbers examined were probably not high enough to give any reasonable hope of success.

DISCUSSION AND CONCLUSIONS

In both Sierra Leone and western Nigeria predators and parasites or *Oryctes* larvae were not at all common. The only controlling factor of this nature seemed to be periodic invasions of the fallen logs by "driver" ants. Standing rotten palm trunks contained large numbers of *Oryctes* in all stages of development. It should not be supposed, however, that there were normally large numbers of these breeding sites in any one small area. Further, not all of the trunks contained *Oryctes.* It was noted that rotten trunks with long black fibers in their interiors seldom supported anything at all. Perhaps the form of decay, fungal or bacterial, made these unattractive to the beetles.

In areas like one reported in western Nigeria where an old oil palm plantation had been poisoned off and the dead palms left standing, serious damage was caused to the young palms planted between them by *Oryctes,* which bred in the rotten trunks.

Parasites and predators were found readily only in the regions of the deltas of the Niger and Cross rivers of eastern Nigeria. While the same species of these are wide-spread throughout West Africa, they were common in this particular area. It is thought that the practice of burning off the bush, which is done on a large scale in western Nigeria and Sierra Leone, plays an important role in limiting the numbers of predators and parasites. The land of the delta areas is too swampy for burning. *Oryctes* is not affected by bush fires on account of its habits.

It is, of course, logical to assume that the long dry season, together with the absence of numerous streams and swamps, probably also plays a major role in limiting populations of parasites and predators which have fairly short life cycles. No doubt it does, but this and burning complement each other, and it is difficult to say which is the more important.

Under West African conditions it appears that many of the populations of *Oryctes* are limited by the number of available and suitable breeding sites, and that their predators and parasites are limited by unfavorable environmental conditions which are determined largely by cultural practices and climatic conditions.